



(19) Europäisches Patentamt

European Patent Office

Office européen des brevets



(11) EP 0 727 677 A1

(12)

EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(43) Date of publication:
21.08.1996 Bulletin 1996/34

(51) Int. Cl. 5: G02B 5/08, B29D 11/00

(21) Application number: 95927950.6

(86) International application number:
PCT/JP95/01532

(22) Date of filing: 02.08.1995

(87) International publication number:
WO 96/04575 (15.02.1996 Gazette 1996/08)

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IE IT LI NL SE

(72) Inventors:
• FUSAMOTO, Akira
Shizuoka-ken 410 (JP)
• TANIKITA, Masumi
Tokyo 175 (JP)

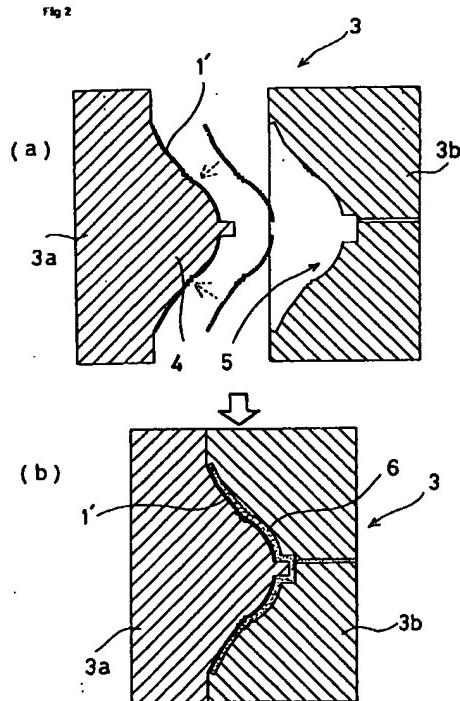
(30) Priority: 03.08.1994 JP 182364/94
22.06.1995 JP 156336/95

(74) Representative: Jackson, Peter
HYDE, HEIDE & O'DONNELL
10-12 Priests Bridge
London SW15 5JE (GB)

(71) Applicant: POLYPLASTICS CO. LTD.
Chuo-Ku Osaka-shi Osaka 541 (JP)

**(54) PRODUCTION METHOD OF LIGHT-REFLECTING COMPONENT AND LIGHT-REFLECTING
COMPONENT PRODUCED BY THE METHOD**

(57) The present invention provides light reflector component having a reflective surface of sufficiently high accuracy. As shown in Fig. 2, an injection mold 3 used to manufacture a light reflector component of the invention includes a male half 3a and a female half 3b. A resin film 1 having a shape of light reflective surface is placed on a protrusion element 4 formed on the male half 3a of the injection mold 3 which is set in a clamp mechanism of an injection molding apparatus (not shown). After the injection mold 3 is closed, a molten resin 6 is injected into a space defined by the male half 3a and the female half 3b.



EP 0 727 677 A1

Description**[Industrial Field]**

- 5 The present invention relates to a method of manufacturing resin components having a light reflector surface as well as to a light reflector component manufactured by the method.

[Prior Art]

- 10 The chief material of parts having a light reflective surface, such as lamp reflectors, has been changed from metal to synthetic resin. At present, most of such light reflector components include a base member composed of a bulk molding compound (hereinafter referred to as BMC) and an aluminum or another metal deposit or coat formed on the light-reflecting surface of the base member.

According to one proposed method of manufacturing a light reflector component, the base member is composed of a thermoplastic resin and the light-reflecting surface of the base member is coated with a metal. This method has been noted because of the good moldability and workability of thermoplastic resins and potential recovery and recycling of the resins.

Another method disclosed in JAPANESE PATENT PUBLICATION GAZETTE No. 3-45688 applies an aluminum sheet previously formed to a shape of reflective surface onto a base member.

- 20 In the conventional method of manufacturing a light reflector component by making the base member out of a BMC and coating the light-reflecting surface of the base member with a metal, application of a primer is required prior to the process of coating the base member with a metal. The primer reduces the roughness of the light-reflecting surface so as to improve the reflecting properties and enhance the adhesive properties of the base member with the metal coating.

Thermoplastic coating material is generally used for the primer, which consumes time for the drying process. The liquid primer often causes sags after coating. As shown in Fig. 5, this may result in uneven coating of a primer 7 on the stepped portions and edges of a base member M, thereby lowering the accuracy of the shape of light reflective surface.

- 25 In the proposed method of manufacturing a light reflector component by making the base member out of a thermoplastic resin instead of the BMC and coating the light-reflecting surface of the base member with a metal, application of a primer is generally required prior to the process of coating the base member with a metal. This method is also not free from the drawbacks accompanied with the application of a primer as discussed above.

In the method of making the base member out of a thermoplastic resin, it is rather difficult to balance the properties required for light reflector components, that is, the heat resistance, strength, and rigidity, with the light reflecting properties. Variation in composition of the thermoplastic resin has been studied for improving the balance. The technique for enhancing the heat resistance, strength, and rigidity is generally in conflict with the technique for improving the light reflecting properties. No practical technique for settling the balance has been completed yet.

- 30 The method disclosed in JAPANESE PATENT PUBLICATION GAZETTE No. 3-45688 forms a thick coating, whose merit is that the light reflecting properties are not affected by the surface of resin components. For the small and simple-contoured components, such as stroboscopes for photography, no problems arise in the process of shaping an aluminum sheet to the light reflective surface. Components having the large and long light reflective surface of complicated shape, such as lamp reflectors of automobiles, have a problem of relatively low accuracy in shape, especially on the stepped portions and edges.

[Summary of the Invention]

- 45 The object of the present invention is to provide a light reflector component manufactured by a simple process to have excellent reflecting properties and good heat resistance and mechanical properties. The first invention is characterized by a method of manufacturing a light reflector component, which includes the steps of: placing a thermoplastic resin film having a shape of light reflective surface closely onto an inner wall of a closed mold; injecting a molten resin into a cavity of the closed mold to form a molded object having a layer of the thermoplastic resin film arranged as a light reflective surface; and coating the layer of thermoplastic resin film with a metal film to complete the light reflective surface. The second invention is characterized by the method of manufacturing a light reflector component, wherein the resin film is composed of any material selected among the group consisting of polycarbonates, thermoplastic polyesters, polyamides, poly(phenylene sulfides), polyarylates, and resins including any one of the preceding polymers as a main component.

55 The third invention is characterized by the method of manufacturing a light reflector component, wherein the molten resin is selected among the group consisting of poly(phenylene sulfides), thermoplastic polyesters, polyamides, and resins including any one of the preceding polymers as a main component. The fourth method is characterized by the method of manufacturing a light reflector component, wherein the molten resin comprises a bulk molding compound.

The fifth invention is characterized by the method of manufacturing a light reflector component, wherein the light reflector component is a lamp reflector.

The sixth invention is characterized by a light reflector component manufactured by a method in accordance with any one of the first invention through the fifth invention.

5 In the present invention, the film includes any thin plate-like sheets.

Preheating the thermoplastic resin film enhances the extensibility and flexibility thereof and allows the thermoplastic resin film to be formed into any complicated shape. The subsequent cooling process enables the thermoplastic resin film to maintain the rigidity while keeping the shape. Even in the case of deep drawing, a desired shape of a uniform thickness can be given to the thermoplastic resin film.

10 The light-reflecting surface of a part coated with a layer of the thermoplastic resin film is comparable to the surface formed by application of a primer. The method of the present invention does not require application of a primer but completes the excellent light reflective surface simply by coating the layer of the thermoplastic resin film on the light-reflecting surface of the part with a metal.

15 An appropriate amount of a primer may be applied with a view to enhancing the adhesive properties of the metal coating with the resin.

[Brief Description of the Drawings]

Fig. 1 shows a process of giving a shape of light reflective surface to a resin film;

20 Fig. 2 shows an exemplified process of producing a lamp reflector according to the method of the present invention;

Fig. 3 shows a light reflective surface composed of a resin film layer;

Fig. 4 shows a lamp reflector as a completed product; and

Fig. 5 shows a conventional example processed with a primer.

25 [Best Mode for Embodying the Invention]

Production of a lamp reflector for automobiles according to the method of the present invention is described with the accompanying drawings.

30 Numeral 1 represents a resin film. A shape corresponding to a concave light reflective surface of a lamp reflector for automobiles is given to the resin film 1.

Although material of the resin film used in the present invention is not specifically limited, preferable examples by taking into account the heat resistance and the optical properties include polycarbonates, thermoplastic polyesters, polyamides, poly(phenylene sulfides), polyarylates, and resins including any one of the preceding polymers as a main component. The preferable thickness of the film ranges from 0.1 to 0.5 mm.

35 In the embodiment, a polycarbonate resin film (0.3 mm in thickness) is used.

A desired shape is given to the resin film 1 by the process of vacuum forming in the embodiment. Referring to Fig. 1, the preheated resin film 1 is closely placed on a projection mold 2 corresponding to a shape of light reflective surface. After the resin film 1 is cured, the non-required periphery of the cured resin film 1 is trimmed to give a contoured resin film 1' having the concave shape.

40 The contoured resin film 1' of concave shape is set into an injection mold 3.

The injection mold 3 includes a male half 3a and a female half 3b and set in a clamp mechanism of an injection molding apparatus (not shown). The male half 3a has a protrusion element 4 corresponding to a shape of light reflective surface of a final product, that is, a lamp reflector, is formed on the male half 3a, whereas the female half 3b has a concave element 5 corresponding to a shape of rear surface of the lamp reflector.

45 The contoured resin film 1' is set in the open mold 3 to come into close contact with the protrusion element 4 of the male half 3a (see Fig. 2(a)).

After the contoured resin film 1' is set in the mold 3, the mold 3 is closed and a molten resin 6 is injected into a space defined by the male half 3a and the female half 3b (see Fig. 2(b)).

50 Although the resin injected into the mold for the above purpose in the present invention is not specifically limited, preferable examples by taking into account the heat resistance, mechanical properties, dimensional stability, and moisture resistance include thermoplastic resins, such as poly(phenylene sulfides), thermoplastic polyesters, polyamides, and resins including any one of the preceding polymers as a main component.

Another preferable example is BMCs including a thermosetting resin, such as an unsaturated polyester resin, as the resin base.

55 Molten resins applied in the embodiment include one obtained by mixing 40% by weight of glass fibers with a poly(phenylene sulfide), one obtained by mixing 30% by weight of glass fibers with a poly(butylene terephthalate), which is one of the thermoplastic polyesters, and a BMC including an unsaturated polyester resin as the resin base.

After the resin composition is cooled and cured, a resulting molded object is removed from the mold. The molded object has a uniform and integral layer of the contoured resin film 1' formed on the concave surface of a base member

EP 0 727 677 A1

M in the shape of a lamp reflector. The layer of the contoured resin film 1' has a fine surface roughness and a high dimensional accuracy (see Fig. 3).

Deposition of aluminum onto the concave surface gives a lamp reflector having a light reflective surface F with high imaging properties (see Fig. 4).

5 The resin film layer is integrally formed on the concave surface of the base member, which is favorable for the light reflecting properties. The concave surface coated with the resin film layer is not affected by the surface properties of the base member. Inexpensive materials even with poor surface roughness may accordingly be used for the resin composition of the base member, as long as it has sufficient heat resistance, mechanical strength, and dimensional accuracy. A filler may be mixed with the resin composition according to the requirements.

10 This structure realizes a light in weight, thin-walled base member and allows a variation in resin composition for the purpose of reinforcing the base member without taking into account the surface properties of the modified composition. Since the degree of freedom is increased for the selection of material, resin components of such structure may go into a wide range of novel applications.

15 As is generally known, surface treatment, such as irradiation of an ultraviolet ray or plasma processing, enhances the adhesive properties of the concave surface coated with an aluminum deposit. Surface treatment of the resin film layer of the embodiment resulted in a significant improvement in adhesive properties of the base member with aluminum.

Table 1 shows the results of a peel test of the aluminum deposit and evaluation of the imaging properties.

The peel test was carried out in the following manner. Each test piece having a resin film layer integrally formed on 20 the surface of a flat plate composed of a base resin (containing 30% by weight of glass fibers) was prepared by the process of insert molding. Aluminum was deposited on the surface of resin film (thickness of deposit: 1,000 angstrom). The peeling properties of the aluminum deposit were evaluated by the 2 mm-squares tape peel test. The results of the peel test and the imaging properties at the time of peel test are tabulated.

For the purpose of comparison, the similar test was performed for BMC base members without a film and PPS base 25 members without a film.

The results of the peel test are expressed as the number of peeled deposits per 100 test pieces.

These results showed that the resin film integrally formed on the surface of the base member significantly improved the adhesive properties and imaging properties of the metal deposit.

30

35

40

45

50

55

TABLE XX1

	BASE MATERIAL	FILM (*1)	DEPOSIT PEEL TEST	IMAGING PROPERTY (*2) (%)
5	PPS	PET	0/100	84.3
10	PPS	PC	0/100	93.6
15	PPS	PAR	0/100	90.5
20	PPS	PA	0/100	80.3
25	PPS	PPS	2/100	80.8
30	PET	PC	0/100	94.1
	PA	PC	0/100	93.0
	BMC	PC	0/100	93.8
	BMC	NONE	45/100	67.2
	PPS	NONE	35/100	70.8
	PPS: poly(phenylene sulfide) PBT: poly(butylene terephthalate) PA : polyamide PET: poly(ethylene terephthalate) PC : polycarbonate PAR: polyacrylate BMC: bulk molding compound			

*1: No primer

*2: Mapping property meter (manufactured by Suga Shikenki)

35 Although the above embodiment refers to a lamp reflector for automobiles, the light reflector component of the present invention may be applicable to stroboscopes for photography, searchlights, and light sources of optical equipment. The thermoplastic resin sheet and the coating metal are not limited to those in the above embodiment.

The light reflective surface may have a convex shape, a flat shape, or any desirable complicated shape other than the concave shape of the embodiment.

40 The method of the present invention integrally forms a resin film layer on the light-reflecting surface of a base member, thereby not requiring application of a primer, which has conventionally been applied prior to the metal coating process. The structure of the present invention thus effectively solves the problem of the conventional structure. Since the surface properties of the light reflective surface are favorably kept by the resin film layer, a desirable resin composition having sufficient heat resistance, mechanical strength, and dimensional accuracy may be freely selected as the base member without taking into account the surface properties of the resin composition.

45 The thermoplastic resin film having the shape of light reflective surface is securely joined with the light-reflecting surface of a base member. This structure ensures a high accuracy of the resulting light reflective surface and is suitably applicable to lamp reflectors having a large and long light reflective surface of complicated shape.

50 Claims

1. A method of manufacturing a light reflector component, said method comprising the steps of: placing a thermoplastic resin film having a shape of light reflective surface closely onto an inner wall of a closed mold; injecting a molten resin into a cavity of said closed mold to form a molded object having a layer of said thermoplastic resin film arranged as a light reflective surface; and coating said layer of thermoplastic resin film with a metal film to complete said light reflective surface.

2. A method in accordance with claim 1, wherein said resin film is composed of any material selected among the group consisting of polycarbonates, thermoplastic polyesters, polyamides, poly(phenylene sulfides), polyarylates, and resins comprising any one of the preceding polymers as a main component.
5. A method in accordance with either one of claims 1 and 2, wherein said molten resin is selected among the group consisting of poly(phenylene sulfides), thermoplastic polyesters, polyamides, and resins comprising any one of the preceding polymers as a main component.
10. A method in accordance with either one of claims 1 and 2, wherein said molten resin comprises a bulk molding compound.
15. A method in accordance with any one of claims 1 through 4, wherein said light reflector component is a lamp reflector.
20. A light reflector component manufactured by a method in accordance with any one of claims 1 through 5.

20

25

30

35

40

45

50

55

Fig 1

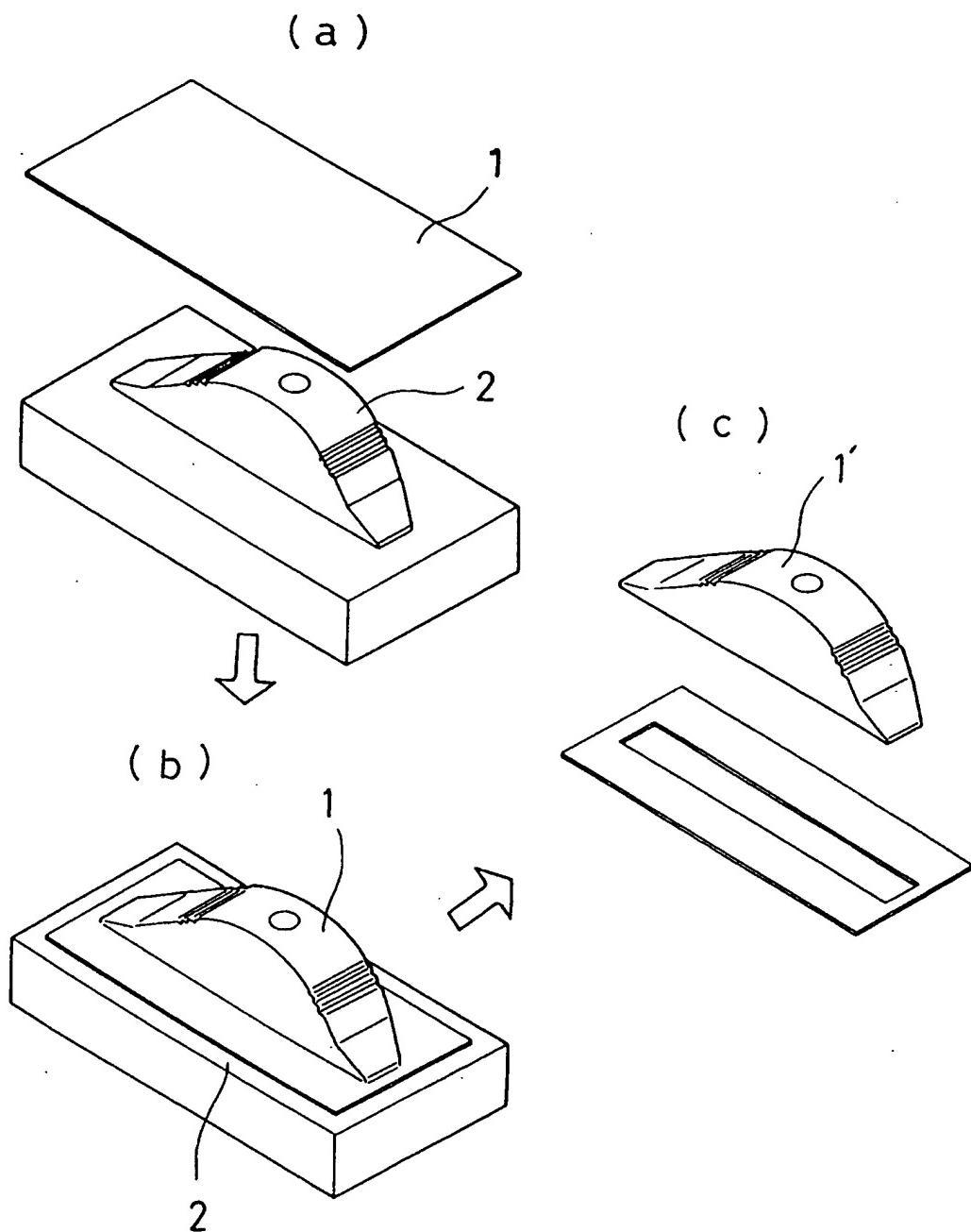


Fig 2

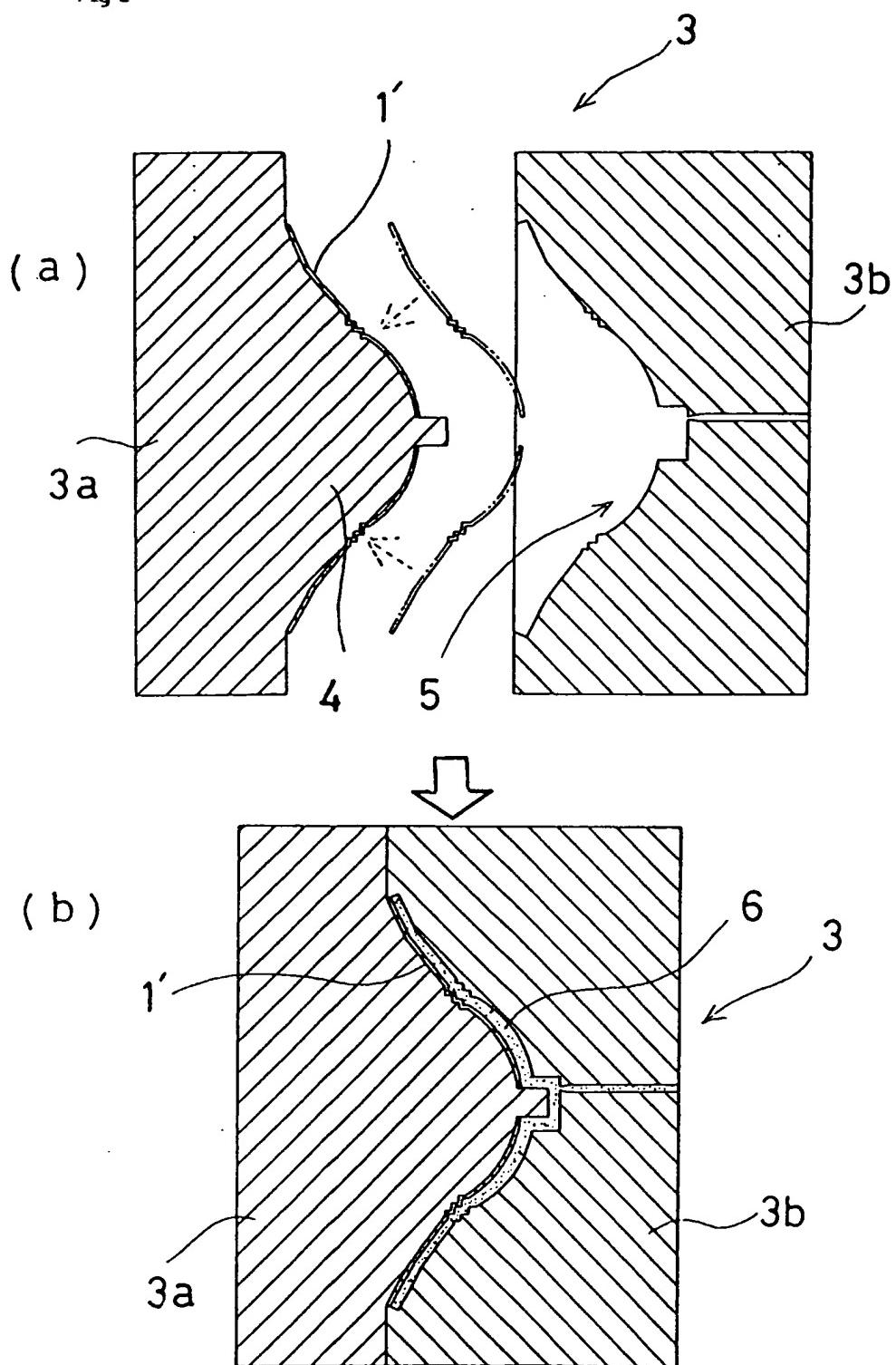


Fig 3

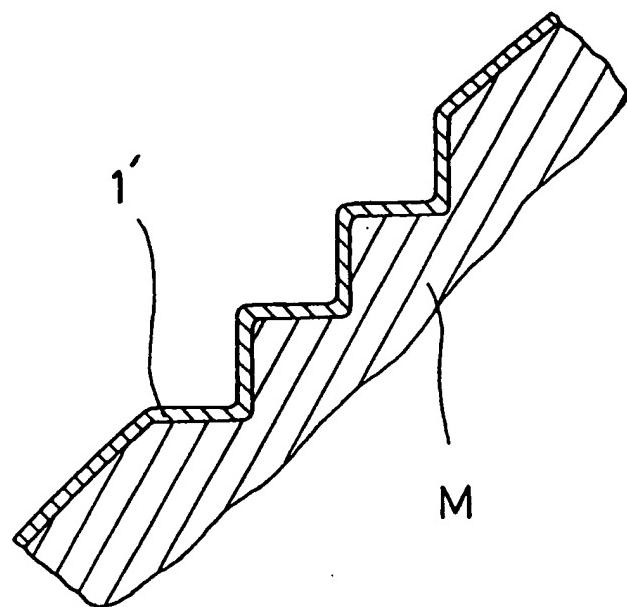


Fig 4

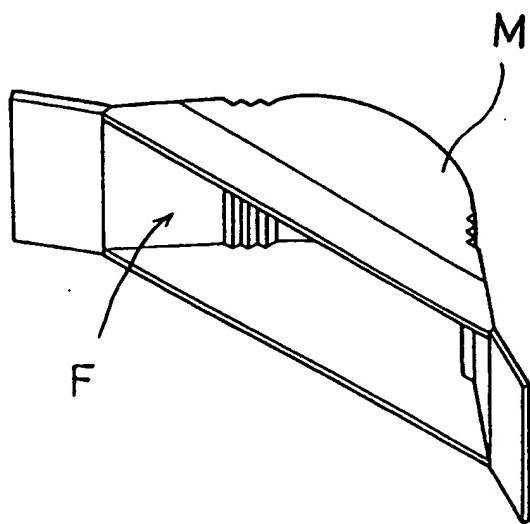
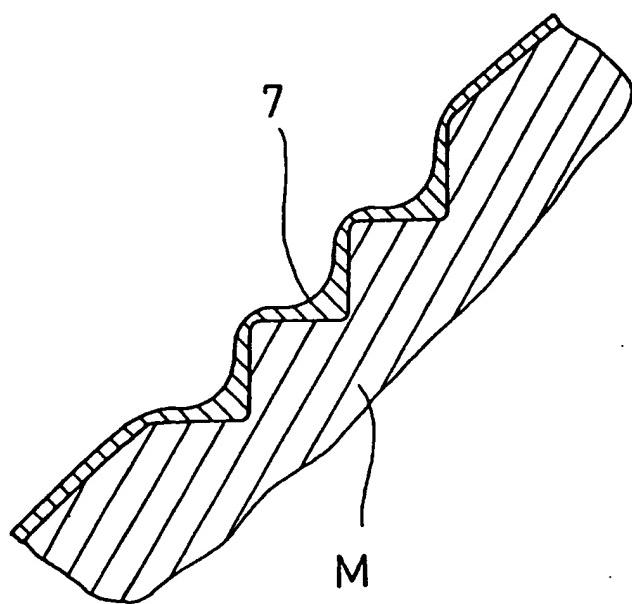


Fig 5



INTERNATIONAL SEARCH REPORT		International application No. PCT/JP95/01532																					
A. CLASSIFICATION OF SUBJECT MATTER Int. C1 ⁶ G02B5/08, B29D11/00 According to International Patent Classification (IPC) or to both national classification and IPC																							
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int. C1 ⁶ G02B5/08, B29D11/00																							
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1926 - 1995 Kokai Jitsuyo Shinan Koho 1971 - 1995 Toroku Jitsuyo Shinan Koho 1994 - 1995																							
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)																							
C. DOCUMENTS CONSIDERED TO BE RELEVANT <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left; padding: 2px;">Category*</th> <th style="text-align: left; padding: 2px;">Citation of document, with indication, where appropriate, of the relevant passages</th> <th style="text-align: left; padding: 2px;">Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 4-320815, A (Siebold Hettinga), November 11, 1992 (11. 11. 92) & US, 5275764, A & EP, 502672, A2</td> <td style="padding: 2px;">1 - 6</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 4-086723, A (Toshiba Corp.), March 19, 1992 (19. 03. 92) & US, 5179464, A</td> <td style="padding: 2px;">1 - 6</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 60-210432, A (Mitsubishi Gas Chemical Co., Inc.), October 22, 1985 (22. 10. 85) (Family: none)</td> <td style="padding: 2px;">1 - 6</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 57-013405, A (NHK Spring Co., Ltd.), January 23, 1982 (23. 01. 82) (Family: none)</td> <td style="padding: 2px;">1 - 6</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 1-309006, A (Hitachi Denshi Ltd.), December 13, 1989 (13. 12. 89) (Family: none)</td> <td style="padding: 2px;">1 - 6</td> </tr> <tr> <td style="padding: 2px;">A</td> <td style="padding: 2px;">JP, 5-124097, A (Nippondenso Co., Ltd.), May 21, 1993 (21. 05. 93) (Family: none)</td> <td style="padding: 2px;">1 - 6</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	A	JP, 4-320815, A (Siebold Hettinga), November 11, 1992 (11. 11. 92) & US, 5275764, A & EP, 502672, A2	1 - 6	A	JP, 4-086723, A (Toshiba Corp.), March 19, 1992 (19. 03. 92) & US, 5179464, A	1 - 6	A	JP, 60-210432, A (Mitsubishi Gas Chemical Co., Inc.), October 22, 1985 (22. 10. 85) (Family: none)	1 - 6	A	JP, 57-013405, A (NHK Spring Co., Ltd.), January 23, 1982 (23. 01. 82) (Family: none)	1 - 6	A	JP, 1-309006, A (Hitachi Denshi Ltd.), December 13, 1989 (13. 12. 89) (Family: none)	1 - 6	A	JP, 5-124097, A (Nippondenso Co., Ltd.), May 21, 1993 (21. 05. 93) (Family: none)	1 - 6
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																					
A	JP, 4-320815, A (Siebold Hettinga), November 11, 1992 (11. 11. 92) & US, 5275764, A & EP, 502672, A2	1 - 6																					
A	JP, 4-086723, A (Toshiba Corp.), March 19, 1992 (19. 03. 92) & US, 5179464, A	1 - 6																					
A	JP, 60-210432, A (Mitsubishi Gas Chemical Co., Inc.), October 22, 1985 (22. 10. 85) (Family: none)	1 - 6																					
A	JP, 57-013405, A (NHK Spring Co., Ltd.), January 23, 1982 (23. 01. 82) (Family: none)	1 - 6																					
A	JP, 1-309006, A (Hitachi Denshi Ltd.), December 13, 1989 (13. 12. 89) (Family: none)	1 - 6																					
A	JP, 5-124097, A (Nippondenso Co., Ltd.), May 21, 1993 (21. 05. 93) (Family: none)	1 - 6																					
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.																							
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed																							
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																							
Date of the actual completion of the international search November 17, 1995 (17. 11. 95)		Date of mailing of the international search report December 5, 1995 (05. 12. 95)																					
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.		Authorized officer Telephone No.																					